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DECISION MAKING IN GLOBAL PRODUCT DEVELOPMENT

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Keywords: global product development, decision making, decision support tools

1. Introduction

In today's global economy, most engineering companies are to some degree global: either global in their market, in their production or global throughout many phases of the value chain. In the manufacturing industry, outsourcing of production to low cost countries is fairly well established [Hansen and Ahmed-Kristensen 2011]. However, over the past two decades, an increasing amount of engineering firms have also globalized development tasks, spanning from R&D to concept development, detailed design, testing, production and marketing [Eppinger and Chitkara 2006], [Lewin et al. 2009]. For companies to stay competitive and take advantage of the global opportunities, traditional co-located product development processes and organisations are often no longer viable, and product development tasks need to be decomposed, resulting in a number of challenges [Hansen and Ahmed-Kristensen 2011]. Engaging in Global Product Development (GPD) requires new competencies and capabilities from engineering manufacturing firms. Some of the key differences between traditional product development (PD) and GPD are: 1) R&D teams become increasingly virtual, and rely heavily on effective virtual collaboration [Eppinger and Chitkara 2006]. 2) GPD requires fully digital product development systems [Eppinger and Chitkara 2006] and 3) GPD results in challenging cultural differences between geographically diverse development teams [Lewin and Peeters 2006]. **Global Product Development** is here defined as a product development operation where product development activities include distributed teams in multiple global locations. The GPD cases reviewed in this study are all manufacturing companies. **Outsourcing** refers to companies sourcing a 3rd party supplier to deliver a certain task or part of the PD process, while **offshoring** refers to companies expanding their development activities in new locations, while maintaining ownership and control of the subsidiary [Hansen and Ahmed-Kristensen 2012].

Previous research shows that companies engaging in GPD often apply a "learning-by-doing" approach if they have little or no experience with outsourcing or offshoring of PD tasks [Eppinger and Chitkara 2006]. A common pattern found in previous studies is that companies often set off by outsourcing late stages of the product development process (e.g. test and production), since these are considered less essential for decision making. Once the companies have gained experience with this, earlier stages of the product development process follow [Hansen and Ahmed-Kristensen 2011]. If earlier stages of product development are globalised, they are most likely offshored, allowing the offshoring company to retain close control over them [Hansen and Ahmed-Kristensen 2011]. When taking the first steps toward a global product development organisation, many companies have no previous experience or extensive assessment to build their decisions upon. Hence decisions are often made in relation to the company's existing footprint (i.e. locations with existing production facilities or other existing activities). Often driven by the immediate cost savings that can be achieved by using low-cost labour for development, these companies experiment with new ventures into GPD, and only when they have

gained experience, they retrospectively assess and evaluate the decisions made [Lewin and Peeters 2006], [Maskell et al. 2007]. Other researchers [Badri 1999], [Lin et al. 2007] have addressed decision making related to the location problem (choosing the right location for outsourcing or offshoring) as well as the make-or-buy decisions [Cáñez et al. 2000], [Cruz-Cázares et al. 2013]. However, we argue that there is still a gap between these nascent theories for decision support in outsourcing and GPD and a structured approach that can be used by decision makers in companies. Therefore, the research-gap this paper addresses is an understanding of whether the established decision making methods are suitable for addressing the challenges identified in GPD.

The rest of this paper is structured as follows: Section 2 presents the research aim and methods, section 3 presents the main literature review, section 4 presents a fit-gap analysis between decision making methods and GPD challenges, section 5 gives a brief discussion of findings, and finally section 6 concludes.

2. Research aim & method

The long term aim of this research project is to identify which information is required for making qualified decisions when outsourcing or offshoring product development tasks, and which decision making methods are suitable to support GPD decision making for companies. This papers overall aim is to investigate the most common decision making methods and their suitability to address the challenges identified in GPD. This is achieved through:

- A summary of motivations and challenges in GPD based on literature and survey results.
- An evaluation of why decisions fail, and which decision making methods are suitable for addressing the identified challenges when making decisions in GPD, based on a review of decision making literature.
- A discussion of the adaptability of decision making methods, and suggested further work.

A literature review is undertaken in order to achieve this aim, where commonality and patterns in existing literature are identified. The literature review is accompanied by a case study, using survey data from Statistics Denmark and Eurostat. Results from the survey data are compared to the literature studies.

3. Literature review & case studies

A systematic search of literature and case studies dealing with GPD was carried out to identify commonality and patterns. Furthermore, literature in the field of decision making was reviewed, and links were drawn between decision making and GPD, in order to identify patterns and gaps, and identify which information is needed to build a decision support tool. In the literature review, three focus areas were taken into account. First, the motivations for outsourcing or offshoring PD tasks found in literature were summarised, complemented by a case study of motivations in Danish manufacturing companies. Second, the most common challenges identified in literature were investigated and compared with challenges in Danish manufacturing companies. The third focus area is decision making literature, where a review of existing decision making approaches related to GPD is presented together with a case study of why decisions fail in Danish companies. These three focus areas serve as a base for identifying missing links between GPD challenges, motivations and decision making.

3.1 Motivations in literature

A reasonable amount of previous research has dealt with the motivations that companies have for outsourcing or offshoring product development tasks. This earlier research is based both on theory and case studies with companies. From this body of research, it is possible to identify some general motivations; an overview of these is presented in Table 1.

Table 1. Motivations for GPD

Motivations	Literature
Reduce development cost	[Eppinger and Chitkara 2006], [Makumbe et al.

	2009], [Hansen and Ahmed-Kristensen 2012]
Shorten development time (time-to-market)	[Zedtwitz et al. 2004]
Improve development quality	[Lewin and Peeters 2006], [Hansen et al. 2013]
Gain access to new market(s)	[Khurana 2006], [Makumbe et al. 2009], [Massini et al. 2010], [Hansen et al. 2013]
Gain new competencies	[Eppinger and Chitkara 2006], [Hansen and Ahmed-Kristensen 2012]
Market strategy	[Massini et al. 2010]
Reduce labor cost	[Eppinger and Chitkara 2006], [Makumbe et al. 2009] [Kumar et al. 2009], [Hansen and Ahmed-Kristensen 2011]
Access to new/better resources	[Maskell et al. 2007], [Hansen and Ahmed-Kristensen 2012],
Reduce project cost	[Hansen et al. 2013]
Reduce supply chain costs (logistics)	[Hansen and Ahmed-Kristensen 2012]
Scalability/flexibility of resources	[Eppinger and Chitkara 2006], [Hansen and Ahmed-Kristensen 2012]

The motivations mentioned most frequently throughout the studied literature are cost related, either with regards to labour-cost savings or other development-cost savings (supply chain costs, overall project costs etc.) i.e.[Eppinger and Chitkara 2006], [Makumbe et al. 2009], [Hansen and Ahmed-Kristensen 2012]. This supports the common understanding that outsourcing will lead to cost savings for the outsourcing company. Access to new markets and access to new competencies is also a recurring motivation in literature; companies often see an opportunity to expand into new markets (i.e. the growing markets in Asia and Africa), through outsourcing. For example a case study by [Khurana 2006] revealed that 52 % of 32 US based case-companies were undertaking international R&D to gain closer access to local markets. The same motivation was stated by some of the Danish case companies in earlier studies [Hansen and Ahmed-Kristensen 2011]. Gaining access to additional resources, which may not be available in the headquarter location of the company, also represents a recurring theme in the articles analysed.

3.2 Motivations in Danish companies – Case study

In order to check for similarity between motivations in literature and industry cases, motivations for outsourcing in Danish companies were also assessed, based on results of a survey provided by Danmarks Statistik [2013]. The survey asked leaders of Danish companies to which extent they considered different motivations as important when outsourcing tasks. The numbers were retrieved for Danish manufacturing companies, the total number of respondents being N=908. The survey was carried out in the period 2009-2011 and includes companies with 50 or more employees. Respondents were asked whether each of 10 different motivations was an important motivational factor for the company when outsourcing PD tasks. The 10 motivational factors are taken from a standardised EU-survey on international organisation sourcing of business activities. The percentages for the motivations are shown in Table 2.

From the survey results it is evident that labour cost reductions are considered the most important motivation by Danish companies who outsource, with 85 % stating that this is a very important or important motivation. Other cost reductions than labour cost are also an important motivation, with 77 % marking this as important or very important. This supports the trend found in literature, considering cost reductions to be the central motivational factor. The data also shows that 57 % said that a strategic decision taken by top management was an important motivation. This is difficult to interpret, as it does not reveal top management's actual motivation. However, it strongly indicates that strategic decisions are being made by top management in order to improve the business by outsourcing. Focus on core business is mentioned by 42 % of the respondents to be an important or very important motivation. This is interpreted as that the companies choose to outsource non-core business tasks, in order to be

able to solely focus on their core business in the headquarters. Access to new markets plays a less important role according to the numbers from Danmarks Statistik, where only around one third of respondents marked this as a very important or important motivation. Both in literature and case studies, it is evident that when companies think of outsourcing or offshoring development tasks, cost savings in various forms is the most common motivation. In general, the numbers from the case study support the challenges found in literature.

Table 2. Motivations for Danish manufacturing companies to outsource. Source: Danmarks Statistik 2013

Motivation	Very important / important (%)	Not important (%)	Not applicable (%)
Reduction of labour costs	85	5	10
Reduction of costs other than labour costs	77	11	12
Strategic decisions taken by the group head	53	17	30
Focus on core business	42	27	31
Access to new markets	29	35	36
Reduced delivery times	26	35	39
Access to specialised knowledge/technologies	20	40	40
Improved quality or introduction of new products	15	42	43
Lack of qualified labour	14	43	43
Less regulation	6	45	49

3.3 Challenges - literature

As with motivations, several studies have considered the challenges companies face when they outsource or offshore PD tasks. An overview of challenges and the literature in which they were studied is shown in Table 3.

Table 3. Challenges

Main challenges	Literature
Cultural differences	[Lewin and Peeters 2006], [Eppinger and Chitkara 2006], [Makumbe et al. 2009], [Massini et al. 2010], [Hansen and Ahmed-Kristensen 2012]
Time zone differences	[Eppinger and Chitkara 2006], [Makumbe et al. 2009], [Roy and Sivakumar 2012]
Knowledge transfer	[Hansen and Ahmed-Kristensen 2012], [Roy and Sivakumar 2012]
Intellectual Property (IP rights)	[Khurana 2006], [Roy and Sivakumar 2011], [Hansen and Ahmed-Kristensen 2012]
Employee retention	[Hansen and Ahmed-Kristensen 2012]
Internal opposition	[Lewin and Peeters 2006]
Interaction distance	[McIvor 2009]
Need for much more documentation	[Hansen and Ahmed-Kristensen 2011]

The single most mentioned challenge in literature is cultural differences [Lewin and Peeters 2006], [Makumbe et al. 2009], [Hansen and Ahmed-Kristensen 2011]. At the same time, cultural challenges is also considered one of the most difficult challenges to address. As GPD has a geographically distributed nature, communication often relies heavily on digital channels rather than face-to-face communication, and this can increase the cultural difficulties experienced among distributed

development teams [Lewin and Peeters 2006]. Challenges regarding knowledge transfer and documentation are also found to be difficult to address [Hansen and Ahmed-Kristensen 2011] as GPD sets new requirements for the way an organisation deals with knowledge management. This is an example of a challenge where some of the companies studied actually experienced increased development times, increased cost etc. This indicates that the capabilities of overcoming these challenges should be included when making a decision assessment. A general conclusion is that many of the challenges identified in literature are related to the fact that GPD is geographically dispersed across different cultures.

3.4 Challenges in Danish companies – Case study

In order to compare the challenges found in literature with experiences in Danish companies, numbers from Danmarks Statistik were analysed to see if the same challenges prevail [Statistik 2011]. The survey had companies rank the importance of barriers for carrying out international sourcing, which we use as an indicator for the challenges they perceive. They were asked to rank the importance of 12 barriers on a three point scale from very important to not applicable/do not know. The total number of respondents is n = 902. Results are shown in Table 4.

Table 4. Barriers for outsourcing - Danish companies (2007). Source: Danmarks Statistik, 2013

Barriers for carrying out international sourcing	Very important (%)	Some importance (%)	Not important (%)	N/A / Do not know (%)
Proximity to existing clients needed	16	22	23	40
Overall concerns of the sourcing operation exceeding expected benefits	15	31	13	41
Legal or administrative barriers	12	34	14	40
Problems with the distance to producer(s)	9	28	22	41
Linguistic or cultural barriers	9	34	19	38
Taxation issues	7	25	25	43
Difficulties in identifying potential/suitable providers abroad	7	26	23	44
Trade Tariffs	6	23	24	46
Uncertainty of international standards	5	25	26	44
Concerns of the employees	4	28	27	41
Concern of violation of patents and/or IP Rights	4	14	33	50
Conflicting with social values of your company	4	22	31	43
Other reasons	1	2	8	89

While cultural challenges receive most focus in literature, the survey results show that the most important barrier is the proximity to existing clients. In addition, 15% said that overall concerns were exceeding the expected benefits. Linguistic or cultural barriers were only considered very important by roughly one out of ten. This indicates that it is not seen much as a barrier by the companies when considering GPD, but it becomes a challenge once the companies have globalised their development.

4. Decisions Making and challenges in GPD (fit-gap analysis)

With the challenges and motivations identified, we now look at why some companies have failed. If a company decides to source back its outsourced activities, this is denoted as a decision failure. As before, a short overview of findings in literature is presented, followed by a comparison with survey data. Additionally literature concerning decision making related to GPD is briefly summarised.

One of the common reasons for decisions to fail is that the expected cost saving targets are not met, and decision makers are surprised by unexpected or hidden costs [Larsen et al. 2012]. This can be triggered by many different factors, some of the observed examples are: cultural and geographic distances [Hansen and Ahmed-Kristensen 2011], difficulties managing a diverse portfolio of projects [Massini et al. 2010] and increased transaction costs from the shift to an external partner [Larsen et al. 2012]. Other reasons decisions in GPD have failed include losing control over the outsourced activity [Barthelemy 2003] and a decrease in product quality [Hansen and Ahmed-Kristensen 2011]. In some of the most extreme cases, this has led the company to “undo” the decision and take back some of the development tasks that they had earlier decided to outsource. In contrast, [Lewin and Peeters 2006] found in their case studies that the cost savings actually exceeded expectations, primarily due to labour arbitrage. This indicates that success related to cost and other factors is very case dependent; cost savings might be achieved in one case, while they fail in others. In their research considering make-or-buy decisions C  nez et al. [2000] conclude that make-or-buy decisions are often made purely on the basis of cost, and that this can lead to failure since other important factors are neglected in the assessment. They propose a more holistic framework, looking at a broader range of aspects such as manufacturing processes, cost, supply chain management & logistics and support systems. They argue that there is a lack of practical and structured approaches for addressing specific make or buy decisions. However, their proposed framework does not directly include assessment of i.e. capabilities for overcoming the most common challenges, such as cultural differences, quality control and documentation. In a study on engineering design outsourcing [Shishank and Dekkers 2013] the authors state that decision making on outsourcing has until now focused only on strategic and operational level. They define design & engineering as the tactical level of decision making (whereas manufacturing etc. are the operational level of decision making). They argue that no sufficient framework is in place to understand outsourcing decisions in relation to design and engineering, neither at the strategic, tactical, or operational level, hence pointing for a need of decision making support at this level.

To acquire an understanding of the reasons why some companies have failed with their outsourcing, data from Eurostat's survey on international organisation and sourcing of business activities [Eurostat 2007] was also analysed. Companies who had back-sourced activities were asked which of eight motivations was important in the choice, with the options of high importance, importance, not important and not applicable. Results were filtered to only include the companies which chose "high importance", leaving the number of respondents $n=42$. They were asked what the main reason for back-sourcing had been, with a choice of eight motivational factors. The percentages for these are shown in Table 5.

Table 5. Reasons for back-sourcing in Danish companies. Source: Eurostat, 2013

1688

Lack of qualified personnel at the foreign location	3	7 %
Higher than expected costs involved in sourcing activities	5	12 %
Problems with supplier flexibility and ability to supply	6	14 %
Strategic decisions taken by the group head	7	17 %
Too long delivery time to customers	8	19 %
Insufficient quality of product/service at the foreign location	9	22 %
Total	42	100 %

4.3 Decision Making Methods and applicability in GPD

The general topic of decision making (DM) and decision making models has a long research history, particularly in the field of Operations Management [Eisenhardt and Zbaracki 1992], [Ho et al. 2010]. Decision making is applied in many fields (i.e. supply chain management, risk management) but has until now received limited amount of attention in connection to outsourcing and GPD decisions (i.e. [Dekkers 2000], [Hafeez et al. 2007], [Kumar et al. 2009]). To demarcate the focus of this literature review, only the decision making methods or models that have been applied in relation to outsourcing or offshoring decisions were included and studied. None of the reviewed research has dealt in detail with assessing the specific parameters actually related to the challenges identified earlier, i.e. which decision parameters must be assessed in order to know whether the company can overcome cultural challenges, interaction distances, need for more documentation etc. In the studied cases, single decision parameters have only been addressed separately for single, specific decisions [Badri 1999], [Cáñez et al. 2000].

To summarize decision making methods and their applicability to GPD decisions, a brief overview of common methods is presented here, and their applicability towards GPD decisions is evaluated. One of the most widely applied decision making methods is the Analytic Hierarchy Process (AHP) that was introduced in 1990 [Saaty 1990]. AHP is a mathematical model based on pairwise comparisons of different criteria, in order to establish a rating and access performance scores for the different alternatives evaluated. AHP decision making addresses how to solve decision problems with high uncertainty and with multiple criteria characteristics. Specific research where AHP has been connected with outsourcing includes [Hafeez et al. 2002] where AHP was used for determining key capabilities of the firm, and by [Badri 1999] where it was used for decisions in location – allocation problems. Other methods include scenario planning, risk breakdown structure and case based reasoning. An overview of the most common decision making methods and their application, advantages and limitations is shown in Table 6. The methods in the table are a mix of quantitative and more qualitative assessments methods, and support different kinds of decision making. Decisions in GPD are very different in their nature (one company might need to decide whether to open a foreign R&D center, another might need to decide on location, and a third company might consider the decision whether to make or buy a product or component). Therefore, in order to evaluate a given decision methods applicability towards GPD decisions, the parameters that must be assessed for such decisions need to be identified. It is not straightforward to identify exactly which parameters are key, but from the previous assessment of challenges and decision failure some parameters which should be included (i.e. cultural fit, communication capabilities) have been identified. It is the core of this study to identify some generalizable parameters that can be used in development of a decision-support tool. Core competencies are a key decision parameter mentioned by several researchers [Shishank and Dekkers 2013], [Zhang 2010]. Only non-core activities are suitable for outsourcing or offshoring. Therefore, an assessment of core competencies should also be included in decision making. This is in line with findings from [Eppinger and Chitkara 2006] and [Kumar et al. 2009]. Since different methods are useful for different GPD decision types, a decision making framework should facilitate assessment of several different parameters such as core competencies as well as capabilities to overcome cultural challenges, capabilities for documentation and communication and the capability to deliver the required quality on time [Hansen and Ahmed-Kristensen 2011]. However, to further inform which exact assessments should be included in the decision making framework (and which specific

decision types should be supported) further studies in manufacturing companies are needed, with the aim to map and analyse their decision processes.

Table 6. Decision making methods and GPD

Reference	Method	Application examples	Advantages	Limitations
[Saaty 1990]	AHP	Location selection Key capabilities	-Systematic - Useful for well-defined problems and options	Difficult to include “soft data”
[Drew 2006]	Scenario planning	Strategic choice Supplier selection	-Encourages learning - A means of testing assumptions -Supports sophisticated treatments and analysis of a company and its environment	- Occasionally too little focus on the decision context. -Relies on soft data. - Time and resource consuming.
[Hillson 2003]	Risk Breakdown Structure (RBS)	Risk assessment	- Lessons learned for future projects - Comparison of projects / tenders - Risk assessment - Risk reporting	- Requires risks to be well defined - Takes time to build experiences
[Brans et al. 1986], [Lin et al. 2007]	PROMETHEE	Selection and ranking of projects Location selection	- Supports more dimensions than AHP alone	- Needs to be combined with AHP
[Choy and Lee 2002]	Case based reasoning (CBR)	Supplier selection	- Enables reuse of engineering knowledge	- Limitations when addressing a wide range of decisions

5. Discussion

In the first sections, it was shown that motivations and challenges have been studied across literature, and there is some agreement of which are the common challenges. From survey data it was also found that these motivations challenges are valid, and that the identified challenges are similar. A field less researched turned out to be the understanding of why decisions fail, and where the literature examples mainly pointed at communication issues, and cultural differences as a main reason for failure, the data from the Eurostat survey show that the main reasons for failure (sourcing back) were actually insufficient product quality and too long delivery times. This may be explained by viewing these differences as causes and effects, with the challenges such as communication leading to the effects, e.g. time delays. This points towards the need for a better understanding of causes and effects in decision failure. Decision making for GPD should include an assessment of both the capabilities of the firm to address cultural challenges as well as an assessment of the suppliers capability to deliver the required quality and the expected delivery times and to include both operational and tactical factors as part of the assessment. While some researchers have touched into the area of DM in GPD, more research is needed to address the specific cases, since existing research addresses decisions from a more strategic perspective, and misses the operational and tactical perspectives. Different methods and views have been presented, both from research in innovation & design and operations management, but so far they seem to have some significant limitations, in their applicability at a tactical level and to address i.e. the issue of poor product quality and delayed delivery times. If multi-criteria decision making methods like AHP, risk breakdown structure, scenario planning etc. are to be used for decision making in GPD, ensuring that the right parameters are assessed is critical. It is also important to define which types of decisions require which types of assessments. A step towards identifying these parameters would be to conduct further case studies, investigating which parameters must be assessed, and then sub sequentially test whether AHP (or any other decision method) actually supports

evaluation of these parameters in a sufficient way. The methods must support an assessment of whether the main challenges (i.e. quality, delivery time, flexibility of resources and the cultural differences) are relevant to the company, and if they are relevant, how they can be addressed. This calls for a more nuanced decision making approach than what is currently in place, and hence requires cross disciplinary work between engineering design discipline and operations management disciplines.

6. Conclusion

In this paper, a literature survey was conducted and survey data was analysed to identify the motivations companies have for engaging in Global Product Development (GPD), and the challenges they face when doing so. An overview of decision making methods from literature, and a brief analysis of the applicability of the most common decision making methods for GPD decisions were also presented. The predominant challenges mentioned in literature were culture, communication and documentation, while the main challenges mentioned by companies from the survey were the need for proximity to existing clients and operations, and overall concerns that outsourcing would not give the expected benefits. The reasons why decisions fail were also reviewed through literature review and survey data. The predominant reasons in literature were: unmet cost savings due to unexpected hidden costs, communication and cultural challenges. The survey data showed quality issues, delivery times and problems with supplier flexibility to be main reasons for failure. This difference indicates that further empirical studies are needed to get a more complete view of why decisions fail, and which parameters must be included in decision making in order to avoid failure. In the analysis of decision making methods and their applicability for decisions in GPD, we found that contemporary decision making literature related to GPD are aimed at very specific questions (such as outsourcing location or make-or-buy decisions) but to this point no decision making model directly addresses all identified challenges in an operational way. The gap identified here is a lack of decision making support tools that can address GPD challenges at an operational and tactical level, i.e. tools that can be applied during engineering design and product development processes. Additional empirical research and subsequent development of a more cross-disciplinary and holistic decision making model for GPD decisions could offer companies better tools for strategic decision support and risk management. Hence, such empirical studies and model development are planned as further research.

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